Biotechnology

unraveling nature's secrets

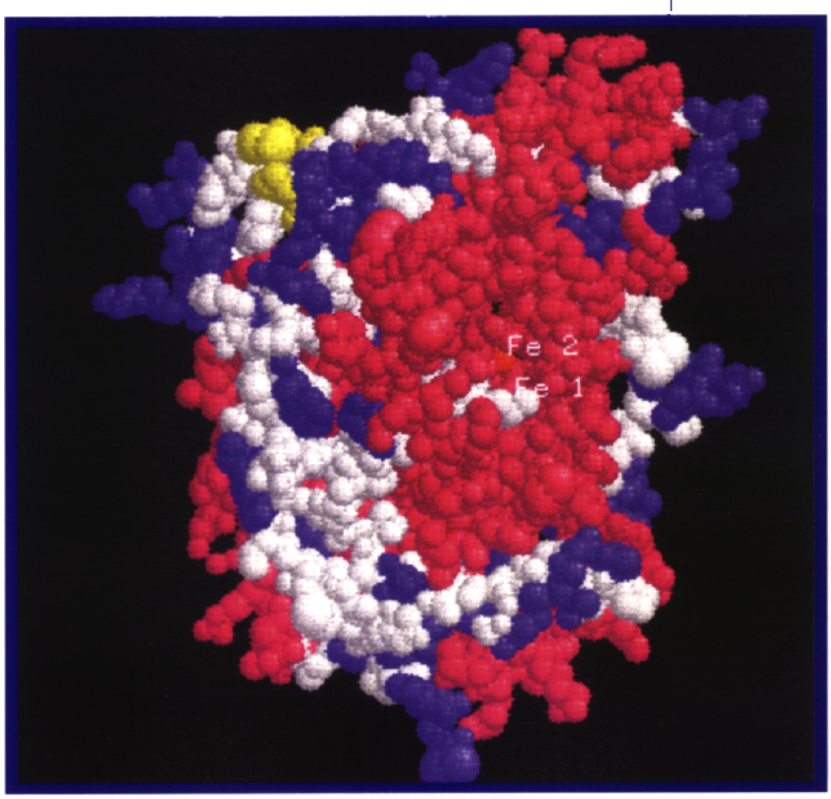
Many separate breakthroughs in molecular genetics and molecular biology led to the current revolution in biotechnology. BES is contributing to this revolution through its biosciences programs, development and use of innovative imaging techniques, and the advanced capabilities of its national user facilities.

Genes isolated and studied by BES scientists are furnishing the medical, industrial, and agricultural sectors with new tools to serve humankind. For example, scientists are now using a number of plant genes to increase the biosynthetic production of the new anticancer drug Taxol (found in Pacific yew trees). In another research effort, a gene that protects corn plants against the European corn borer has been transferred into the plants themselves, thus reducing the need for pesticides. Finally, the development of the model plant *Arabidopsis thaliana* and the sequencing of its genome have yielded both herbicide-resistant plants important for agriculture and plants with altered lignins useful to the pulp and paper industry.

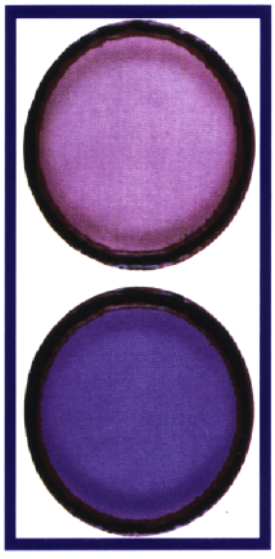
Scientists are also studying a whole new way to manufacture plastics — in plants! If researchers can commercialize this process-in which a gene allows certain kinds of bacteria to manufacture biodegradable plastic in the plant — plastics, which are so important in today's world, can be manufactured in an environmentally friendly way.

BES work has also laid the foundation for developing analytical imaging and diagnostic technologies that can be applied to biological systems. These technologies include single-molecule detection for analyzing nucleotides from DNA and double-mass fragmentation spectroscopy for determining the structure of protein, DNA fragments, and carbohydrates. In addition, BES studies of radioactive atoms led to the synthesis of one of the most widely used positron emission tomography tracers in the world for clinical research and diagnosis.

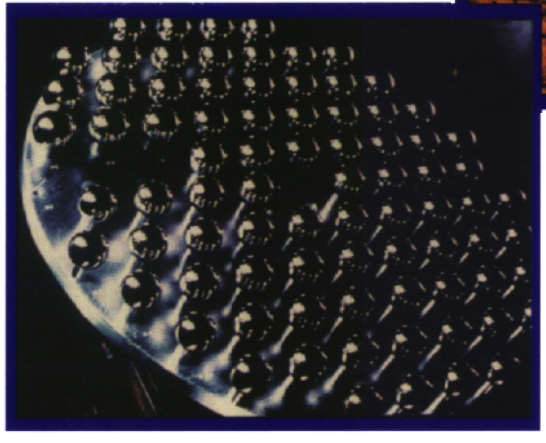
Many biological researchers and companies are using BES synchrotron facilities to collect detailed information about the three-dimensional structure of biological macromolecules. This new information in turn has led researchers to design new enzymes that produce inexpensive fuels and chemicals.



Researchers at Brookhaven National Laboratory have used data on protein structure to design a new enzyme that can be engineered into biological systems. The new enzyme allows researchers to synthesize a new lipid (a class of compounds useful in a number of chemical-related industries).



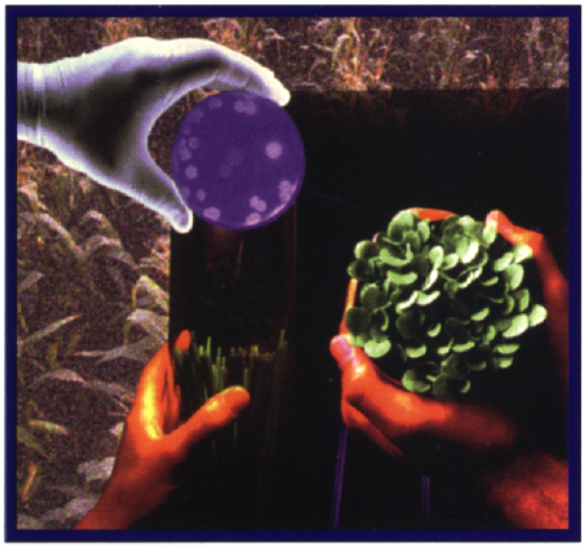
With a simple color change from blue to red, a monomolecular film created by researchers at Lawrence Berkeley National Laboratory signals the presence of biological or environmental entities. These sensors could be used to identify substances ranging from toxic compounds to bacteria and viruses.



Inset: Spire Corporation prepares the "balls" for artificial hip joints for ion implantation. The large tilt-rotation platen allows nearly 100 orthopedic devices to be processed at one time.

Ion Implantation

Each year, more than 100,000 artificial hips, knees, and other orthopedic devices are manufactured using an ion implantation technique developed by Oak Ridge National Laboratory and the University of Alabama at Birmingham. This surface treatment, which dramatically improves wear resistance, has now been implemented by several companies for a variety of orthopedic applications.



Plant Biotechnology

Plants and photosynthetic microorganisms are solar energy transducers that produce fuels and useful chemicals. BES supports fundamental research at the Michigan State University/DOE/Plant Research Laboratory into the mechanisms of how plants grow, metabolize, and reproduce. This research provides the foundation for the use of biological systems in energy-related technologies ranging from the production of liquid fuels to the synthesis of biodegradable plastics.